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TITLE

FALL CONTROL WITH PENETRATING SPRAYS AGAINST THE MOUNTAIN PINE BEETLE IN WESTERN WHITE PINE 1942

SUBJECT—

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Coeur d'Alene, Idaho

January 15th, 1944

To: F. C. Craighead, in Charge, Forest Insect Investigations

From: James C. Evenden, Box 630, Coeur d'Alene, Idaho

Subject: Penetrating Sprays - Mountain Pine Beetle Control

I am enclosing two copies of a laboratory report by Mr. Gibson entitled, " FALL CONTROL WITH PENETRATING SPRAYS AGAINST THE MOUNTAIN PINE BEETLE IN WESTERN WHITE PINE * 1942 ". You will note that although the controls on dry logs were successful the tests of 6-, 8-, and 10 - 1 mixtures of fuel oil and orthene did not give and significant promise of success. We would appreciate your comments and criticism of this work.

James C. Evenden

cc: Parker
Furniss
Keen
Wygant

FALL CONTROL WITH PENETRATING SPRAYS AGAINST THE MOUNTAIN PINE BEETLE IN WESTERN WHITE PINE
1943

Justification and Objective of Work

The heavy losses caused annually by the mountain pine beetle in western white pine have been emphasized in the past and need no repitition to point out the need for improving control methods for this important pest. The use of penetrating sprays has been found to possess many advantages over previous control methods, the best of which employ fire as the lethal agent. Limitations in the working period imposed by hazards in the use of this agent during late spring and early summer, do not apply to penetrating sprays.

Any method having no working period limitations would be of increased value, especially under present conditions where limited manpower might have to be employed over a long period of time to complete a control project. Up to the present time experiments and control with penetrating sprays in western white pine have been limited largely to spring and early summer. It was to determine if penetrating sprays gave effective control in the fall as well as in the spring and summer that tests begun in the fall of 1941, were continued in 1942.

Conditions Pertaining to the Experiments

Control work in western white pine in the fall is subject to the handicap of frequent and often prolonged rainfall as well as snow. Furthermore, average daily temperatures decrease with the approach of winter. Warm weather, apparently necessary for control with oil-base sprays, is seldom experienced at that time of the year. Consequently, spray applied to infested material in the fall would have to remain there all winter and until warm weather of late spring or early summer before having a lethal effect. Retention of lethal qualities after a minimum of six months exposure to severe weather conditions would seem to require a very potent spray.

The material used in these tests were 3-foot white pine logs infested with brood which varied from eggs to new adults in development. For the experiments, the logs were separated into two general brood-development divisions, one containing only eggs and tiny larvae, the second, larger larvae and in some logs pupae and new adults. Logs containing immature brood, eggs and tiny larvae, were expected to offer more resistance to the penetration of spray because of the almost moisture-saturated green bark. Bark on logs containing more mature brood is drier and was expected to absorb the oil-base sprays much more readily. The experiments included seven logs in each of these two divisions of brood development.

It was recognized that many trees might be more or less wet after fall rains or snows. To simulate severe wetting conditions such as might occur to standing, infested trees after a prolonged, heavy, driving rain or following an early snow, the logs were first sprayed with

enough water to thoroughly saturate the surface. The oil-base spray was applied immediately after this preliminary spraying.

Spraying logs to surface saturation with water, does not give conditions exactly comparable to those following heavy rains. Spraying logs that are standing, to imitate the trunk of a standing tree during rain, would result in the loss of much of the sprayed-on water from splashing and drifting of the finer drops. From observations, it is believed as much rain splashes from a tree trunk as remains on it. Also, rain usually falls at a comparatively slow rate, giving a much longer time for it to be absorbed. Thus rain-soaked bark that is surface saturated is likely to contain considerably more water than bark of similar saturated appearance where the water has been rapidly spray-applied.

In spraying with the equipment used, water is applied so that a surface-saturated appearance is reached within about 20 seconds on a square foot of bark surface. The thickness of the applied water layer to give this appearance is about .016 of an inch; applied at the rate of about three inches an hour. The amount that gives the surface-saturated appearance would naturally vary with the type of bark, deeply ridged, rough, thick, dry bark requiring more than a thin, smooth, green surface. However, for the average log we may consider the preceding figure for water-layer thickness, to be representative.

Rainfall necessary to produce a similar surface-saturated condition would be considerably more than .016 of an inch. It is believed from three to four times the preceding amount would be necessary to give the same appearance. From the preceding discussion it may be seen that rainfall that would produce an equal layer of water to that sprayed on the logs in the same length of time, rarely ever occurs in nature. Therefor, we may consider the plan of the experiments for wet logs as representing much more severe conditions than ordinarily arise on a control project. By the same reasoning we may expect the results to be a very conservative indication of the control to be expected from sprays applied subsequent to even a heavy rain.

The Experiments

One spray consisting of six parts of Diesel oil to one of orthodichlorobenzene and a second of eight parts Diesel oil to one of orthodichlorobenzene, were applied to logs given the previously described preliminary wetting. Just as with water, the spray was applied until the bark surface was saturated, as indicated by the glisten of accumulated spray and the imminence of run-off. These treatments were deferred until October 20 or later in order to represent conditions on a control project being conducted late in the fall.

After spraying, the logs were left on the ground, with only sufficient natural or artificial shading to prevent solar killing. Examinations of these logs were made in July of 1943. Data from the tests on dry logs are summarized in Tables 1-A, 1-B, and 1-C and in Tables 2-A, 2-B, and 2-C. For wet logs the data are given in Tables 3-A, 3-B, 4-A and 4-B.

Tables of Data Concerning Fall Control With Penetrating Sprays Against the Mountain Pine Beetle in Western White Pine

Table I-A

Material - Dry logs containing eggs and small larvae
Spray - Six parts of Diesel oil to one of orthene(1)

Date exam.	No. of Tree	No. of Log	Sq.ft.of area exam.	Surviving Lar.	Pup.	N.A.	Remarks
7-28	1	9	1.5	--	--	--	
"	2	13	4.0	2	--	--	
"	3	1	2.0	--	--	--	
"	3	7	3.0	3	--	--	No apparent reason for survival of two larvae
"	3	19	1.5	--	--	--	
"	4	1	1.25	--	--	--	
"	5	17	1.5	--	--	--	
Totals			13.75	5	--	--	Survival - .36 per sq.ft. or 98% mortality from spray

(1) Orthodichlorobenzene

Table I-B

Material - Dry logs containing eggs and small larvae
Spray - Eight parts of Diesel oil to one of orthene

7-28	1	10	1.0	--	--	--	Bark still green
"	2	14	2.0	--	--	--	
"	3	6	2.0	1	--	--	No indicated reason for survival of larva
"	3	16	1.5	--	--	--	
"	3	21	1.0	--	--	--	Bark still green
"	4	6	1.25	--	--	--	Bark still green
"	4	13	1.5	5	1	--	No apparent reason for survival of well-scattered insects
Totals			10.25	6	1	--	Survival - .68 per sq.ft. or 96.2% mortality from spray

Table I-C

Material - Dry logs containing eggs and small larvae
Spray - Ten parts of Diesel oil to one of orthene

7-28	1	11	1.5	--	--	--	Bark still green
"	2	15	1.5	--	--	--	
"	3	2	2.5	--	--	--	
"	3	17	1.5	--	--	--	
"	4	2	1.25	1	--	--	No apparent reason for survival of one larva.
"	4	9	1.25	--	--	--	Bark still green
7-7	4	15	1.5	--	--	--	
Totals			11.0	1	--	--	Survival - .09 per sq.ft. or 99.5% mortality from spray

Table II-A

Material - Dry logs containing large larvae, pupae, and callow adults
Spray - Six parts of Diesel oil to one part of orthene

Date exam.	No. of Tree	No. of Log	Sq. ft.of area exam.	Surviving Lar.	Surviving Pup.	Surviving N.A.	Remarks
7-28	2	1	3.0	--	--	--	
"	2	8	5.0	--	--	--	
"	3	9	3.0	--	--	--	
"	5	3	2.0	--	--	--	
"	5	9	1.5	1	--	--	Surviving larva sickly and previous experience indicated it will die
"	5	15	1.0	--	--	--	
"	1	4	1.5	2	--	--	One of surviving larvae sickly, other normal in appearance
Totals			17.0	3	--	--	Survival - .18 per sq.ft. or 99.0% mortality from spray

Table II-B

Material - Dry logs containing large larvae, pupae, and callow adults
Spray - Eight parts of Diesel oil to one part of orthene

7-28	5	8	1.0	--	--	--	
"	5	1	3.0	9	--	2	Survivors well scattered
"	3	14	2.5	--	--	--	
"	3	8	3.0	1	--	--	
"	2	10	2.5	--	--	--	
"	1	1	2.0	1	--	--	
"	5	16	2.0	1	--	--	Surviving larva sickly
Totals			16.0	12	--	2	Survival - .75 per sq.ft. or 95.8% mortality from spray

Table II-C

Material - Dry logs containing large larvae, pupae, and callow adults
Spray - Ten parts of Diesel oil to one part of orthene

7-28	1	8	1.5	--	--	--	
"	2	6	3.0	--	--	--	
"	2	12	3.0	--	--	--	
"	3	4	2.5	--	--	--	
"	1	2	2.5	3	--	--	One of the surviving larvae sickly
"	5	5	2.5	--	--	--	
"	5	13	1.25	--	--	--	
Totals			16.25	3	--	--	Survival - .18 per sq.ft. or 99.0% mortality from spray

From the preceding data it is seen that excellent control on dry logs was secured with all spray concentrations and brood development stages tested. Furthermore, the equally good results obtained with the weakest spray compared with those that are stronger, indicate that an even weaker and consequently slightly cheaper spray may be effective.

A surprising result of the tests was the equally good control obtained on logs whose bark was green as on those with drier bark. As indicated previously, it was believed the green bark would offer more resistance to the penetration of the spray than that which was dry.

Inspection of the tables reveals the survival of occasional insects. However, these survivors are chiefly larvae, subject to further normal as well as spray-induced mortality prior to emergence. With only two out of 42 logs showing control less than 90 percent, it is felt they cannot be considered as giving a significant indication of spray failure.

Estimates of control with the various sprays were based on comparison of living brood found in untreated and treated logs, both examined at the same time. Had all living insects been in the new adult stage, ready to emerge, the data would give an accurate measure of the effectiveness of the treatments. That, however, was not the case. In untreated material 17.8 percent of the total brood was larvae, 9.4 percent pupae, 56.7 percent new adults, and 16.1 percent had emerged. Normal mortality can be expected to reduce the number in these stages prior to emergence. Bedard found the following reductions occurred; to large larvae 58.2 percent, to pupae 24.1 percent, and to new adults 15.3 percent. The preceding mortality figures were only for normal mortality. On treated material an added reduction may be expected from further action of the spray. However, because the separation of normal and spray-induced mortality in treated material might be subject to considerable error, no attempt has been made to correct the data to the probable emergence figure. The living brood found at the time of examination has been considered as that which might emerge in both treated and untreated material. Because surviving brood in treated material includes a larger proportion of larvae than that from check logs, the indicated percent of control is lower than it would be if corrected for even normal mortality. However, relative positions as to control effectiveness of the various sprays, would not be changed and the percent of control given may be considered as quite conservative.

There are indications that the weaker solutions require a longer exposure to warm weather to become effective than more concentrated sprays, although final control may be the same.

The writer wishes to emphasize the necessity of deferring judgement as to the effectiveness of Diesel-oil orthodichlorobenzene sprays until the treated material has been subjected to a number of days of the high temperatures of summer. Even as late as July 28 there were some living, but comparatively inactive larvae, apparently dying from the effect of the spray. Often arresting of development of brood, for a more or less extended period, seems to be the only effect. Observations over a number of years of tests revealed that this inactive condition results in death of the brood. Thus we may have a lapse of as much as nine months from time of treatment until conclusions as to spray effectiveness can be drawn.

Results from Treating Wet Logs

The procedure in treating logs initially sprayed with water has already bee given. Only concentrations of 6 to 1 and 8 to 1 were used in these tests. The results are shown in Tables 3-A, 3B, 4-A and 4-B.

Table 3-A
Material - Wet logs containing eggs and small larvae
Spray - Six parts of Diesel oil to one of orthene

Date exam.	No. of Tree	Log	Sq.ft.of area exam.	Surviving Lar.	Pup.	N.A.	Remarks
7-27	4	4	2.0	7	--	--	Surviving larvae well scattered
"	4	7	3.0	--	--	--	Part of bark still green
7-28	4	10	1.0	11	1	1	Most survivors in 4 sq.ft.of sample. Most of bark green. Survivors apparently normal.
"	4	12	1.35	--	--	--	Part of bark still green
7-27	3	3	3.0	2	1	--	Scattered survivors
"	3	18	1.5	--	--	--	Bark green
"	3	20	2.0	--	--	--	Bark green
Totals			13.75	20	2	1	Survival - 1.67 per sq.ft. or 90.7% mortality due to spray

Table 3-B
Material - Wet logs containing eggs and small larvae
Spray - Eight parts of Diesel oil to one of orthene

7-28	3	5	1.5	4	2	3	
"	3	15	3.0	--	--	2	Some of bark partly green
"	3	22	2.0	2	5	5	Green bark
7-27	4	3	3.0	1	1	3	Much green bark
"	4	8	1.5	--	--	--	Green bark
"	4	11	2.5	13	9	6	Heavy survival on part of log, none on rest. Part of bark green.
"	4	14	2.0	8	--	--	Much of bark still green
Totals			15.5	28	17	19	Survival - 4.13 per sq.ft. or 77.0% mortality from spray

Table 4-A
Material - Wet logs containing large larvae, pupae, and callow adults
Spray - Six parts of Diesel oil to one part of orthene

7-27	1	5	2.0	3	--	--	Heavy recent mortality
7-28	2	4	1.5	--	--	--	
"	2	7	2.0	--	--	--	Strong odor of spray
"	3	12	1.25	14	5	7	Heavy brood had been present
7-27	5	4	1.0	1	3	7	Five beetles had emerged. Much
"	5	12	1.0	12	6	5	recent mortality
"	5	14	1.0	8	3	5	
Totals			9.75	38	16	24	Survival - 8.0 per sq.ft. or 55.6% mortality due to spray

Table 4-B

Material - Wet logs containing large larvae, pupae, and callow adults
Spray - Eight parts of Diesel oil to one part of orthene

Date exam.	No. of Tree	Log	Sq.ft.of area exam.	Surviving Lar.	Pup.	N.A.	Remarks
7-28	1	7	1.0	7	1	1	Some recent mortality
7-27	2	3	3.0	--	--	--	
"	2	5	4.0	3	--	--	Some recent mortality
7-28	2	9	3.5	2	1	--	Considerable recent mortality
7-27	3	10	3.0	11	3	15	
7-28	5	6	1.0	5	3	8	Heavy recent mortality even in pupal and new adult stages
"	5	10	2.0	6	4	--	Heavy recent mortality
Totals			17.5	34	12	24	Survival - 4.0 per sq.ft. or 77.8% mortality from spray

Inspection of Tables 3 and 4 reveals no consistent control. Only in Table 3-A were the average results satisfactory and even there, control in at least one tree was unsatisfactory at the time of examination. The other three tests showed unsatisfactory results. Acceptable control in one tree would be offset by high survival in the next.

It is quite apparent that spraying will not give consistently satisfactory control under the conditions set up in this experiment. The results from these tests must not be construed as indicating that any moisture on the bark surface would prevent adequate control. A 4 to 1 spray on wet logs gave satisfactory results in similar experiments conducted the previous year.(1) There is undoubtedly a point of water concentration on bark surface beyond which satisfactory control can not be obtained, but that amount would have to be determined by further experiments.

Six of the seven untreated logs used to furnish brood survival data for comparison with similar data in treated material, are shown in Table 5. Brood in the seventh had been destroyed by ants. In counting brood present in check logs, it was necessary to consider only one adult had emerged from each emergence hole. Where brood survival has been heavy, more than one adult may use the same emergence hole, but the actual number doing so cannot be accurately determined. For this reason it is believed the estimate of 18.0 insects emerging per square foot of bark surface is conservative, but is used for want of a better figure.

(1) Fall Control of the Mountain Pine Beetle in Western White Pine With Penetrating Sprays. A.L.Gibson, 1942. Report at Forest Insect Laboratory, Coeur d'Alene, Idaho.

Table 5

Material - Untreated logs as a check against those treated
Treatment - Interspersed among the treated logs to expose to similar environmental conditions

Date exam.	No. of Tree	No. of Log	Sq.ft.of area exam.	Surviving Lar.	Pup.	N.M.	N.A.E.H. (1)	Remarks
7-28	1	6	1.0	4	9	24	--	
"	2	11	--	--	--	--	--	Ants had killed brood under bark.
"	3	11	3.0	11	1	8	5	
"	4	5	2.0	12	2	--	--	Much of bark still green
"	5	2	1.0	--	--	39	12	
"	5	7	2.0	1	--	15	8	
"	5	11	1.0	4	5	16	4	
Totals			10.0	32	17	102	29	Potential emergence 18.0 per sq. ft.

Summary and Conclusions

From the preceding experiments it is seen that fall control is effective against the mountain pine beetle in western white pine. However, tests conducted in 1941 as well as in 1942 show that only four parts of Diesel oil to one part of orthodichlorobenzene is effective against brood in wet logs. On dry logs alone concentrations as low as ten parts of Diesel oil to one of orthodichlorobenzene have proved effective. This weaker spray is cheaper by 30 percent than the four to one formula.

With the weaker sprays, six to one and eight to one, control against brood in logs previously surface-saturated with water , was insufficiently effective. However, this is believed to be due to the severe conditions of the experiment. Less water on the bark, duplicating conditions normally encountered on a control project following rain or snow, probably would not prevent acceptable control. Tests under more normal conditions are needed to establish that and are suggested as soon as conditions permit.

The feasibility of fall control, as indicated by the experiments reported in this and previous papers, broadens the period during which control can be conducted in western white pine to the entire spring, summer, and fall seasons. This longer working period gives the use of penetrating sprays a decided advantage over the previously preferred method which employed fire. With the latter method the uncertainty of the onset of dangerous fire conditions, made it necessary to concentrate all spring control into a short period early in the season, when working conditions are more or less unfavorable. The previous necessity of training and employing a large crew in order to complete a project during the short work period could now be supplanted by a smaller crew requiring less equipment and overhead, employing it for a longer period, and during more favorable weather. Practically the same advantages apply to the use of penetrating

sprays for fall control. Previously, fire danger deferred control operations until much later in the fall than spraying could have been started. Thus by using sprays a longer work period is available in both spring and fall, thus favoring greater efficiency and economy.